Chapter 5

Nutrient Management Plan of Land Application of Septage Waste

5.1 Nutrient Management Plan of Septage Waste Application

An effective nutrient management plan takes into consideration the following:

- Identifying the crops and the quantities of major nutrients (nitrogen, phosphorus, and potassium) required by the crops to be grown.
- Type and amount of the crop nutrients supplied from various sources such as septage waste, previous crops, chemical fertilizers, and animal manure.
- Realistic yield goals for the crops to be grown.
- Results of soil, plant, animal manure, or septage waste testing.
- MSU nutrient recommendations for crops to be grown or calculated nutrient removal for crops to be grown.
- Hydraulic loading rates for soils receiving septage waste that will not cause nutrient leaching.
- Practices developed to minimize loss of nutrients and maximize crop yields.

5.2 Soil Nutrients and Septage Waste

Plants or crops need at least 17 chemical elements to grow and be healthy, and these 17 elements are considered to be "essential nutrients." Three essential plant nutrients (carbon, oxygen, and hydrogen) make up about 95 percent of plant dry matter. These three nutrients are obtained from water (H_2O) and the air as carbon dioxide (CO_2) and oxygen (O_2). The other 14 essential plant nutrients come principally from the soil.

Three of these 14 nutrients, nitrogen, phosphorus, and potassium, are called major or primary nutrients and are needed in relatively large amounts by crops. Varying amounts of these three nutrients are usually included in fertilizer, or nutrient recommendations for crops, depending on what the crop is and what the expected yield is. Generally, some amount of these three nutrients must be added, because the plant-available amounts in the soil are not enough to meet the crop's needs. For some soil/plant situations in Michigan, nutrient recommendations may also be given for other essential plant nutrients besides nitrogen, phosphorus, and potassium, when soils cannot provide adequate amounts to meet a crop's need.

For the three major plant nutrients, septage can provide nitrogen and phosphorus but very little, if any, potassium. Since most potassium discharged into a septic system is soluble, it is carried with effluent leaving the septic tank to the on-site sewage disposal system, so very little potassium remains in the tank as septage. Therefore, the two major nutrients discussed in this manual are nitrogen and phosphorus. When septage is applied to land, these two nutrients should be managed to ensure that adequate quantities are available for optimal crop growth but that excess amounts are not added that can negatively impact water quality.

5.3 Importance of Nitrogen

Nitrogen is one of the essential plant elements and is important in plant development. Nitrogen is part of many essential plant components, especially amino acids, which are the building blocks of proteins.

Nitrogen deficiency results in poor plant growth. Poor plant growth results in less nutrients being taken up by plants, which in turn may reduce the need of septage that can be applied to the land site.

On the other hand, nitrogen in excess of plant requirements can lead to potential leaching of nitrate nitrogen below the root zone to contaminate groundwater. Nitrogen is taken up in soil solution mainly in the form of nitrate and ammonium ions.

The uniform application of septage waste at an agronomic rate helps to provide optimum but not excess nitrogen, which will reduce the introduction of excessive nitrate nitrogen into groundwater. Typically, nitrogen added to soils will be converted to nitrate nitrogen by bacteria. High concentrations of nitrates can leach to groundwater. Nitrates in drinking water can cause health problems, especially for infants[1, 3].

5.3.1 Nitrogen Level in Soil and Nitrogen Soil Test

Inquiries have been made by septage waste haulers why nitrate nitrogen levels are not reported in the standard soil test reports. In Michigan, there is a nitrate-nitrogen test called the presidedress soil nitrate test (PSNT) that can be used for field corn or sugarbeets. Soil samples must be collected between May 15 to July 15, and results are used for making a sidedress application of nitrogen. Most soil testing laboratories do not test nitrate as part of a routine or basic soil test. This is mostly due to the fact that nitrate concentrations in soils are very dynamic and can change very quickly, making this test potentially unreliable for determining how much nitrogen may be available to crops.

Note: If you decide to request the soil laboratory to run a PSNT test, make sure you follow the directions as to how and when to sample the soil and how to handle the soil sample prior to submission to the laboratory for analysis. The PSNT test is not recommended.

5.3.2 Sources of Nitrogen in Soils

Some common sources of nitrogen at land application sites include:

- Septage.
- Biosolids* from WWTPs.
- Chemical fertilizers.
- Legumes.
- Manure**.
- Plant residues.

* Do not apply biosolids to a land site currently authorized and used for the land applications of septage waste in the same cropping year[2]. Land application of biosolids to a MDEQ authorized site would require approval from the department.

** It is not recommended that manure be applied to an authorized land site where septage is land applied in the same cropping year. However, where manure is applied to such a land site, or will be applied, a comprehensive nutrient management plan is to be developed and submitted to the MDEQ that accounts for the nutrient contribution from manure.

5.4 Importance of Phosphorus

Phosphorus is the other essential plant element discussed in this manual. Phosphorus is a key component of adenosine triphosphate (ATP), which is considered the energy source for many plant processes. It is also an essential component of deoxyribonucleic acid (DNA), a key part in genetics (hereditary) and ribonucleic acid (RNA), an important player in protein synthesis.

5.4.1 Phosphorus Deficiency and Excess

Phosphorus deficiency results in stunted plant growth and poor seed development. Over application of phosphorus can lead to accumulation of total and available phosphorus in the soil. Excess phosphorus in soil can potentially increase its solubility and mobility leading to its migration or movement to lakes, streams, rivers, and other bodies of surface water. Phosphorus in surface waters can contribute to eutrophication (accelerating growth of algae and aquatic weeds).

5.4.2 Sources of Phosphorus in Soils

Common sources of phosphorus in soils at land application sites include:

- Domestic septage waste.
- Biosolids from WWTPs.
- Chemical fertilizers.
- Manure.
- Plant residues.

5.4.3 Soil Phosphorus Test at Septage Waste Application Sites

The maximum allowable concentration of phosphorus in soils at septage waste application land sites is 300 lb P/ac (or 150 ppm P) using the Bray P1 method, or 340 lb P/ac (or 170 ppm P) using Mehlich method[2], Part 117.

Septage shall not be allowed to be land applied when the phosphorus level in soil at the land site has exceeded the maximum allowable concentration.

Conversion Factor: Phosphorus in soil test reports is usually reported in pounds per acre (lb/ac) or parts per million (ppm)

It is possible to convert from one unit to the other as shown below.

Parts per million (ppm) to Pounds per acre (lb/ac)
ppm x 2 = lb/ac
Example: 98 ppm Phosphorus = 98 x 2 = 196 lb/ac

5.4.4 Phosphorus Uptake and Loss

Crop uptake of phosphorus has been reported to be 18 to 53 lb/ac/year depending on crop type and yield[4].

Other Conversions:	lb/ac x 1.12 = kg/ha	ppm (wet) = mg/L
	kg/ac x 0.893 = lb/ac	
	lb P_2O_5 = lb P x 2.29	lb K_2O = lb K x 1.20
Explanations:	kg/ha (kilograms per hectare)	mg/L (milligrams per liter)
	P_2O_5 (phosphorus pentoxide)	K_2O (potassium oxide)
	P (phosphorus)	K (potassium)

Phosphorus Loss

In general, phosphorus can be lost from the soil[1], which includes soils at land sites from one or a combination of the following:

- In dissolved surface runoff water (0.01 to 2.68 lb/ac).
- In eroded soil particles (mineral and organic) (0.09 to 8.93 lb/ac).
- Crop uptake (4.47 to 44.65 lb/ac).
- Other chemical processes.

5.4.5 Managing High Soil Phosphorus Levels at Land Sites

What to do when soil phosphorus test level is “High.”

The following steps will assist in managing the phosphorus levels in soils at land application sites.

Check the Phosphorus Level

Determine the soil phosphorus test level at your land site by conducting soil tests. Make sure that soil samples are properly taken. Refer to Appendix K about how to take soil samples. Take more than one composite sample if soil variability at the site is present.

Phosphorus Nutrient Plan Readjustment

When the soil phosphorus test level as shown in the soil test report is in the high range, but still less than 300 lb P/ac (150 ppm P), nutrient management should focus on phosphorus instead of nitrogen. The application of additional phosphorus sources from septage waste and/or chemical fertilizers should be significantly reduced or discontinued. Design and implement a nutrient management system that will assist in reducing the phosphorus level in the soil. Consider an alternate method of calculating the agronomic application rate based on phosphorus rather than nitrogen. See Sections 6.9 and 6.10 for additional information.

Furthermore, crops that are good phosphorus removers from soil such as alfalfa, bromegrass, orchard grass, timothy, or sorghum-Sudan grass should be grown to help remove phosphorus from the soil. In general, the largest nutrient removals are achieved using legumes and perennial grasses that are cut frequently in their early stages of growth[4]. Some haulers in Michigan have reported that they noticed remarkable decline in phosphorus levels in some of their high yielding corn fields when grown and harvested for silage.

Factors Affecting the Reduction of Soil Phosphorus Test Levels in Soils

The degree and rate of soil phosphorus test reduction depends on a number of factors including, but not exclusive to:

- Soil pH.
- Type of soil.
- Type of crop.
- Health of crop.
- Amount of phosphorus that can be removed by crop harvest.
- Nutrient balance of essential macro and micro nutrients.
- Management (how the crops and soils are treated).

Consult Appendix I for additional information about field crops and their ability to remove phosphorus in soil.

For additional information about nutrient removal, consult reference 5.

Phosphorus Monitoring and Evaluation

When your soil phosphorus test levels are high, it is recommended that you test the soil and evaluate the phosphorus status annually. High phosphorus level in soil cannot be reduced overnight. It may take several years to notice a significant decline in the soil phosphorus test level. For this reason, it is important not to over-apply septage or supplemental fertilizer at your land site.

5.5 References

1. Brady, Nyle C. and Weil, Ray R. 2002. The Nature and Properties of Soils. 13th Ed. Prentice Hall, Upper Saddle River, New Jersey 07458.

2. Michigan Biosolids Law. 1999. Part 24, Land Application of Biosolids. NREPA, R 323.2410(8).

3. Nugent, Mike, Michael A. Kamrin, Lois Wolfson and Frank M. D'Itri. 1993. Nitrate – A Drinking Water Concern. MSUE Bulletin WQ-19

4. USEPA. 1981. Process Design Manual. Land Treatment of Municipal Wastewater. EPA-625-1-81-013.

5. Warncke, D, J. Dahl, L. Jacobs and C. Laboski. 2004. Nutrient Recommendations for Field Crops in Michigan. MSUE Bulletin E-2904.